THE PHILIPPINE
JOURNAL OF SCIENCE
D. GENERAL BIOLOGY, ETHNOLOGY, AND ANTHROPOLOGY

VOL. VIII AUGUST, 1913 No. 4

A DESCRIPTION OF SOME PHILIPPINE THALASSEMÆ WITH A REVISION OF THE GENUS

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Two plates and 3 text figures

During a residence at the marine biological station of the University of the Philippines and the Bureau of Science at Port Galera, Mindoro, in 1912, I collected 3 species of *Thalassema*. One of these, *Thalassema sorbillans* Lampert, was described from the Philippines in 1883 and has not been recorded elsewhere. Another, *Thalassema semoni* Fischer, has been previously recorded from Amboina by Fischer, and from the Maldive Islands by Shipley, but has not before been found in the Philippines. The third species is new, and I have called it *Thalassema griffini* in honor of Dr. L. E. Griffin by whose aid and encouragement I have been able to complete this paper. Later in the year, Mr. A. L. Day, of this laboratory, on a trip of the Government cableship *Rizal*, obtained one specimen of a species which seems to be *T. formosulum* Lampert. A brief description of this specimen has been included.

Thalassema sorbillans Lampert.

Thalassema sorbillans LAMPERT, Zeitschr. f. wiss. Zool. (1883), 39, 340; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 352.

Numerous specimens of this species were collected from a sandy beach on Buquete Island, Port Galera. The sand was fine, containing much organic matter to a depth of about 15 cm.; at this depth it passed abruptly into a layer of coarse, clean gravel. *Thalassema sorbillans* was found in the top layer of sand, more than 100 specimens being collected in a space 1 meter square. I was able to keep a number of individuals alive in an aquarium for several days, but was so busy with other work that I did not have much time for observing them. They were able to burrow in the sand without any difficulty, and fed by taking up pellets of sand and passing them through the intestine.

The body of this species is from 3 to 5 cm. in length, and the proboscis is more than half as long as the body. Both the body and proboscis may be extended to about twice the usual length when the animal is feeding or moving about on the surface of the sand. The diameter of the largest specimens measures from 14 to 16 mm. The body is rather pointed at both ends, and 2 short curved setæ are borne from 5 to 10 mm. back of the mouth on the ventral surface. The body wall is so thin that the internal organs often may be seen through it. Small papillæ are scattered over all parts of the body, but are most numerous and prominent on the posterior region.

As in Lampert's specimens, there are 13 bundles of longitudinal muscles. Even in the largest specimens these are very small and thin, and in the smaller and younger individuals they cannot be detected by means of the microscope.

Cross sections were made of the central part of the body wall of 4 specimens ranging from the youngest to the oldest, in order to compare the dermal muscle layers. In the youngest specimen the longitudinal muscle is continuous and of very nearly uniform thickness. In the next individual there are 13 longitudinal swellings of the longitudinal muscle, although it remains continuous all the way around the body. In the third specimen the bundles have become thicker, while between the bundles the muscle has decreased considerably in thickness. In the fourth and oldest specimen the longitudinal bundles are comparatively thick, while the muscle between the bundles has become attenuated, as if it had been pulled out, until it has a thickness of only one row of fibers in some places, and in others it even has disappeared entirely. In all the sections the oblique muscle layer is very thin, but it is continuous and uniform in thickness, and follows the outline of the longitudinal muscles. In the spaces in which that muscle is lacking, the oblique layer is separated from the circular layer only by connective tissue.

The color of the living worm is a rich brownish pink. The presence of the longitudinal muscles is indicated in the larger specimens by 13 white longitudinal lines. The proboscis is pale cream color on the dorsum; faint green lines run along the edges of the groove on the ventral side. In formalin both the body and proboscis become nearly colorless.

There are 3 pairs of unusually small nephridial sacs, of which the posterior pair is always the largest. In a specimen 7 cm. long the sacs measured, respectively, 2, 3, and 5 mm. in length. The anterior pair always lies in front of the ventral setæ, the second pair about an equal distance back of the setæ, and the second and third pairs are always about twice as far apart as the first and second. Each sac bears 2 spirally twisted nephridia which enter the sac by a common opening on the dorsum just within the attachment of the sac to the body wall.

The anal trees are long, brown in color, and open into the rectum on the left side. Lying between them is a small spherical diverticulum of the rectum (fig. 1). The anal trees are covered with short ciliated funnels which are plainly visible under a magnification of 50 diameters.

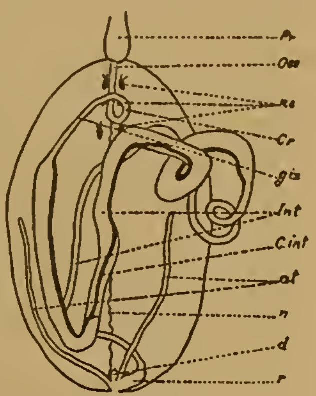

FIG. 1. Diagram of the internal organs of *Thalassema sorbillans* Lampert. *pr*, proboscis; *ne*, nephridial sacs; *oes*, œsophagus; *cr*, crop; *giz*, gizzard; *int*, intestine; *c. int*, collateral intestine; *r*, rectum; *d*, diverticulum; *at*, anal trees; *n*, nerve.

The alimentary canal has a total length of about 36 cm. in the largest specimens. It may be divided into 5 parts—œsophagus, crop, gizzard, intestine, and rectum. This form differs from the majority of echiuroids in that there is no muscular pharynx, the mouth opening directly into the thin-walled œsophagus, which is a straight tube about 1 cm. long. The "heart" is attached to its dorsal surface, and the two connecting blood vessels pass around it. Behind the "heart," the crop forms a loop, which when straightened out is about 1 cm. long. From it the gizzard, or "midgut," runs transversely to the left. This organ has a length of about 2 cm., and is smaller in diameter than the crop. At the end of the gizzard the canal widens greatly, the walls become much thinner, and the intestine may be said to begin at this point. The intestine is divided into two parts. The first part has a diameter of from 4 to 5 mm., a length of about 15 cm., and bears the collateral intestine throughout its length. The latter organ is about 1 mm. in diameter, and its walls are thicker than those of the main part of the intestine. Both of its openings into the intestine may easily be found. The second part of the intestine, which begins at the end of the collateral intestine, is a little longer than the first part, but is much smaller in diameter. The course of the intestine is rather complex, but seems to be nearly constant in the specimens I have examined. From the gizzard it runs posteriorly on the left side almost to the rectum. Then it turns to the right, and extends forward to a point about even with the posterior surface of the crop. Here it turns ventrad, and passing under the other parts runs posteriorly until it reaches the left side of the rectum again. Turning to the right it forms an S-shaped loop and enters the rectum from the right. The rectum is less than a centimeter long; its diameter is only a little greater than that of the intestine. In addition to the intestine, it receives the anal trees, and bears a small spherical rectal diverticulum.

The œsophagus is attached to the body wall for the first 5 mm. of its length by means of 2 sheets of muscular filaments which run laterally to the wall just back of the mouth. The remainder of the canal is held in place by means of thick muscular bands which extend latero-ventrad from its ventral surface to the body wall. These bands are very numerous along the upper part of the intestine, but decrease in number toward the posterior end. The rectum has a radial mesentery, and the diverticulum is attached by filaments to the sheath of the nerve cord.

In one specimen dissected a very remarkable variaton of the crop was noted (Plate I, fig. 1). In place of the simple loop, the walls of the tube had grown together in such a way as to form a heart-shaped sac which was partially divided into 2 chambers by the fusion of the adjoining walls of the tube. The œsophagus was slightly constricted where it entered the sac, and the gizzard was somewhat shorter than usual.

The vascular system of *Thalassema sorbillans* agrees very closely with that of other species of the genus which have been described in detail. The dorsal blood vessel enters the body cavity from the proboscis. It runs backward on top of the œsophagus until it reaches the posterior part where it is enlarged to form a sac-like "heart." Out of the posterior end of this "heart" run 2 vessels which pass around the œsophagus on opposite sides and join the ventral vessel. This vessel runs forward, and divides into 2 branches which enter the proboscis as the lateral vessels of that organ. The body cavity is filled with a clear fluid containing brownish red corpuscles. In the cœlomic fluid of all the specimens which were examined there were also great quantities of the "corpuscular bodies" which have been described by Ikeda(20).

The nervous system consists of a long ventral cord which runs from behind the mouth to the anus. At its anterior end it divides into 2 branches which run around the œsophagus and enter the proboscis. The cord bears no ganglia, but it gives off numerous small branches which supply the body walls.

Thalassema semoni Fischer.

> *Thalassema semoni* FISCHER, Zool. Forschungsr. in Australien, etc. Semon (1896), 5, pt. 3, 338; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 351; Fauna and Geography of the Maldive and Laccadive Archipelagoes Echiuroidea (1902), 1, pt. 2, 129.

Two specimens of *Thalassema semoni* Fischer were collected on Buquete Island in holes in a sandstone rock along with many specimens of *T. griffini* (see page 249).

The body when extended was about 7 cm. long. The proboscis was about three-fourths that length, and was broad, flat, and slightly truncated. The proboscis broke from the body very easily, and did not leave a visible scar. Both of the specimens were perfect when they were found, but their probosces were broken off before they could be brought to the laboratory. The bodies of the preserved specimens are 4 cm. in length and 15 mm. in diameter; the probosces are greatly contracted. The body wall is rather tough, and is covered uniformly with papillæ. The two ventral hooks are present, but are very small and inconspicuous. The longitudinal muscle layer is continuous, showing no division into bundles.

Both the body and the proboscis were olive green when the animals were alive. In formalin they turned to dirty gray.

There are 2 pairs of nephridial sacs each bearing spirally twisted nephridia. The sacs are very long in proportion to the length of the body, the posterior pair in one specimen being longer than the body when straightened out. They are constricted at intervals, and contain partly developed eggs. The anterior pair opens in front of, and the second pair behind, the ventral hooks.

The anal trees are slender brown tubes about two-thirds as long as the body. They are covered with very small ciliated funnels.

The alimentary canal is about 34 cm. long. It is composed of 5 parts—pharynx, œsophagus, midgut, intestine, and rectum. The pharynx is about 5 mm. long and 2 mm. in diameter, and has thick muscular walls. It is held in position by means of 2 lateral mesenteries. The œsophagus is very much twisted, but has a length of about 2.5 cm. when it is removed and straightened out. Its walls are very much thinner than those of the pharynx. The next part of the canal, which I have called the midgut, is about 5 cm. long; it runs backward from the end of the œsophagus for about half its length, then turns on itself forming a U, and runs forward again where it turns to the right. The walls of this part are thicker than the œsophagus, but there is no indication of any separation into crop and gizzard such as is found in many other forms. The intestine as usual is composed of two parts. The first part, bearing the collateral intestine, is about 10 cm. long, and is much wider than any other part of the canal except the rectum. The second part is longer and narrower than the first part, and is filled with small regular pellets of sand. The rectum forms the last 15 mm. of the canal. It is a sac-like organ about 8 mm. in diameter, and bears the anal trees at its lower end.

The vascular and nervous systems agree in almost every respect with the typical forms of the genus.

Thalassema formosulum Lampert.

Thalassema formosulum LAMPERT, Zeitschr. f. wiss Zool. (1883), 39, 339; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 340.

One individual of this species was collected by Mr. A. L. Day near Catbalogan, Samar. It was brought up on a cable from a depth between 10 and 24 fathoms. The bottom was of fine mud.

The length of the preserved specimen is 4.5 cm., and its greatest diameter is 18 mm. The proboscis is about 1 cm. long, and forms a tube at the mouth. The body is slightly pointed in front, while the posterior end is broad and flat with the anus opening on a small projection. The body wall is very thin, and is sparsely covered with small round white papillæ which are nowhere arranged in rings.

The longitudinal muscles show 7 narrow bundles, the spaces between the bundles being from two to three times as wide as the bundles. On sectioning, the dermal musculature was found to be unusually thick in proportion to the remainder of the body wall. The longitudinal muscle was found to be continuous, although it has the 7 thickenings which have been mentioned. The muscle of the bundle is between two and three times as thick as that of the region between the bundles. In all 3 layers the muscle has an unusual lack of compactness; the fibers, which are very large as compared with other forms, being scattered in a loose connective tissue which is full of small sinuses. The ventral setæ are long and hooked, with orange-colored tips. Internally, they are attached to the body wall by strong radial muscles, and their ends are connected by a powerful interbasal muscle.

In formalin the body is colorless, except the flattened posterior end, which is white.

There are 2 pairs of very small nephridia which open behind the ventral setæ. Owing to the smallness of the nephridia and the poor state of preservation of these organs, the character of the internal openings could not be determined.

The anal trees are about 2.5 cm. long and rather broad and sac-like. They are suspended from the body wall by muscular filaments. The structure of the funnels could not be distinguished. A spherical, rectal diverticulum is present.

The intestine was filled, except for the first 2 cm., with very small sausage-shaped pellets of mud.

Although this specimen is somewhat larger than *T. formosulum* as described by Lampert, the number and position of the nephridia, the arrangement of the longitudinal muscles, and the general external appearance of the specimen seem to justify identifying it as this species.

Thalassema griffini sp. nov.

Locality.—Port Galera, Mindoro. This species was first collected on the inner side of Buquete Island in a soft blue sandstone rock just above low-water mark. The rock was honeycombed with burrows made by a boring mollusk (*Gastrochæna?*), and the *Thalassema* was found in these old burrows along with *Gebia* and other crustaceans. In order to get them out, it was necessary to break up the rock with a crowbar. They were found in this place in considerable numbers during the entire time the station was occupied (March 12 to June 18). They were also collected in great numbers on the outer side of the island during most of the month of April. Here there is a small cove with a rock bottom into which numerous shallow potholes have been worn by wave action. These are partly filled with sand, gravel, and small stones. *Thalassema* was collected from the deeper holes. In one hole not over 60 cm. in diameter, 11 specimens were found and in another, 10, along with an equal number of sipunculids. They seemed to lie directly on the rocks with the sand and gravel covering them, and no definite burrows or openings could be observed on the surface. On the 1st of May they had entirely disappeared from this place, and could not be found there during the remainder of our stay at the station.

Size.—The bodies of the largest specimens reach a length of from 12 to 14 cm. when fully extended, with a diameter of from 10 to 12 mm. The proboscis varies in length from 5 to 8 cm.

If the animal be irritated, its body contracts to the shape and size of a large olive, and the proboscis is much shortened. I succeeded in killing specimens fairly well expanded by leaving them in sea water to which a little atropin was added from time to time.

The greatest thickness of the extended body is just back of the mouth, from which it tapers to a point at the posterior end. The two setæ are orange tipped, and are placed on the ventral surface near the mouth. The body wall is tough, and the longitudinal muscles are prominent. They are found in 17 or 18 bundles, the proportion of specimens having 18 bundles to those having 17 being nearly as 5 to 1. The surface of the body is covered with small papillæ which are especially prominent on the terminal regions, those of the posterior end being arranged in more or less definite rings.

Color.—In the living specimens the general color of the body is red, with broad white stripes running lengthwise. These correspond in number to the longitudinal muscles. The proboscis is bright green on the ventral side along the edge of the groove, and shades to a cream color on the dorsal surface. The tip is bright yellow, and the groove is pale yellow. When the circular muscles contract, the surface of the body is broken into deep red squares which appear and disappear as the peristaltic wave passes along the body.

Nephridia.—All of the specimens examined possess 3 pairs of nephridial sacs, the anterior pair always opening in front of the setæ. Each sac bears 2 spirally coiled internal openings. The sacs are always very much elongated, in some specimens the posterior sac being as long as the body; all contained eggs or spermatozoa when collected.

Anal trees.—These organs are clear transparent sacs, and are about one-half the length of the body. They are covered with microscopic, sessile, ciliated funnels.

THE BODY WALL

(FIGS. 3, 4, AND 5)

For the purpose of description it will be necessary to divide the body wall into three parts; namely, the anterior and posterior terminal regions and the middle portion. The anterior and posterior terminal regions are thickly covered with papillæ, and show no differentiation of the longitudinal muscle into bundles. In preserved specimens they extend for about 1 cm. from each end of the body. On the middle portion, the papillæ are smaller and scattered, and the longitudinal muscle is divided into 18 distinct bundles. The body wall is rather thick in both terminal regions, but becomes much thinner in the middle of the body.

As in other forms the wall is made up of a corium—consisting of the cuticle, epidermis, and dermis—the muscular layer, and the endothelium. The corium layer resembles the usual forms very closely. The cuticle is very thin and transparent. The epidermis consists of a layer of long cylindrical cells, the inner ends of which are produced into fine tapering processes such as are described by other writers. All over the surface and especially in the terminal regions, the epidermis is pushed out by thickenings of the dermis to form small papillæ. In the epidermal layer of these papillæ are found groups of long club-shaped cells which have a granular appearance and open on the surface by common pores in the cuticle. The dermis consists of a clear ground substance containing numerous long anastomosing fibers and very few cells, which gives it a more or less reticular appearance. Its thickness varies greatly in different places as it forms the main internal mass of the dermal papillæ. Inclosed in the dermis are found numerous large rounded bodies containing granules which stain deeply with hæmatoxylin. They do not appear to be connected with the surface, and no explanation of their function has occurred to me.

On taking up the study of the dermal muscle layer it was found to be so different from any other form that it seemed worthy of a rather detailed description. The description and drawings were nearly finished when a paper by Spengel(43) was received; Spengel describes specimens of *T. erythrogrammon*, in which the skin muscle layer is very much the same as in *T. griffini*. Spengel has compared 7 different specimens which have been described at various times as *T. erythrogrammon*. They are:

1. The original example of the species found by Rüppell in the Red Sea.
2. A specimen described by Lampert in 1883 as *T. caudex* and later referred to the species *T. erythrogrammon*.
3. An example in the Vienna Royal Museum, from Bourbon, identified and described by von Drasche in 1881.
4. Sluiter's specimen from the Island of Billiton, between Sumatra and Borneo, described in 1883.
5. A specimen collected by Willey in the China Straits near New Guinea and described by Shipley in 1899.
6. An example from the Bahamas described by C. B. Wilson in 1900 and a specimen from Florida in the possession of Spengel.
7. Specimens collected by Gardiner at the Maldive Islands and identified by Shipley in 1902.

Spengel has studied the dermal muscle layer of all of these forms, and on the basis of the difference in this structure he has divided the genus *Thalassema* into three separate groups, without regard to the number of longitudinal muscle bundles which they display. In the forms which have been described as having separate bundles of longitudinal muscle, he finds that "all have an uninterrupted, continuous layer of longitudinal muscle which is regularly thickened and intermittently thinned," thus giving the appearance of separate bundles except when examined very carefully under the microscope. He says also that in all forms the circular or ring muscle forms a continuous uniform sheet. Therefore, he separates his groups according to the degree in which this thickening and thinning of the longitudinal layer is found and the manner in which it occurs.

The first group for which he retains the generic name *Thalassema* and for which he takes the type species, *T. neptunii* Gaertner, as the type, has the following characteristics. The longitudinal muscle is of uniform thickness throughout, and the oblique muscle is also of uniform thickness and completely covers the longitudinal layer. The second group to which he gives the generic name *Listriolobus* is characterized as follows: The longitudinal muscle is thickened into bundles at intervals, and is not interrupted between the bundles, but simply becomes thinner, forming undulations. The oblique layer is like that of *Thalassema;* that is, of uniform thickness and completely covering the longitudinal layer. To this genus he assigns *T. erythrogrammon* of Sluiter and Wilson and the specimen which he has from Florida. To the third group he gives the old generic name of Rüppell—*Ochetostoma.* This group is characterized by having the main part of the longitudinal muscle interrupted by "intervals," so that longitudinal bundles are formed which appear to be separated, but are in reality connected by a very thin layer of longitudinal fibers between the bundles. The oblique muscle does not follow the longitudinal layer in the intervals, but bridges the intervals on septal bands of connective tissue. Also, the oblique muscle is not a continuous sheet as in the other forms, but is separated into bundles over the "intervals," so that these are connected with the cœlom by openings between these oblique bundles. In this genus he places the original *T. erythrogrammon* of Rüppell and Lambert's *T. caudex.* The position of the other specimens he does not define.

The dermal muscle layer of *T. griffini* bears a very close resemblance to that of *T. erythrogrammon* Rüppell, but there are some differences from the condition which Spengel describes and some points have been noted which he does not bring out in his description. In *T. griffini* the dermal muscle layer consists of four parts. The first of these is a single layer of muscle cells lying at the base of the dermis, which runs in a longitudinal direction and covers the body throughout, completely separating the corium from the deeper muscle layers. This layer is so thin that it is very difficult to see in cross sections of the body wall, but it is easily found by peeling off the corium in glycerine and then examining with the microscope. On account of its position and relations to the surrounding parts, I have called it the external limiting muscle. Within the external limiting muscle are the three regular muscular layers—the circular or ring muscle, the longitudinal muscle, and the oblique muscle.

In order to make clear the relations between these muscles, it will be necessary to describe the middle or longitudinal layer first. In the two terminal regions which have been mentioned, the longitudinal muscle forms a thick continuous sheet without any separation whatever into bundles (fig. 5). At about 1 cm. from each end, this sheet gradually becomes separated into 18 large longitudinal bundles. In cross section these bundles have the shape of a more or less regular isosceles triangle with the base lying against the inner oblique layer and the apex turned outward. Between the bundles are the "intervals" of which Spengel speaks. He says that in Rüppell's specimen of *T. erythrogrammon* a very thin, but continuous, layer of longitudinal muscle continues across the intervals from the apex of one bundle to the next. In *Thalassema griffini* traces of this layer may be found, but in place of the continuous layer of which Spengel speaks it is broken up into small bundles of fibers and these bundles are scattered across the interval. These little bundles rarely consist of more than 10 muscle fibers, and they are in almost all cases separated by a space greater than the width of the bundles and in some cases the space between them may be as wide as half the whole interval. They are surrounded by connective-tissue fibers and overlaid by the endothelium (fig. 3).

The circular muscle on the outside of the longitudinal muscle is a continuous sheet in the terminal regions, about half the thickness of the longitudinal layer. In the middle region of the body the circular layer also changes in character. It becomes much thinner, and is spread out flat over the large longitudinal bundles, but over the intervals between them it is drawn together more or less to form bundles which are connected by a very thin layer of fibers.

The oblique or diagonal muscle on the inner side of the longitudinal layer is also continuous over the terminal regions although somewhat irregular in thickness, and it follows closely the outline of the longitudinal layer. In the middle region its condition is exactly like that described by Spengel; that is, between the longitudinal bundles, the oblique fibers are gathered into compact cords which bridge the intervals (fig. 2). On reaching the edges of the longitudinal bundles, the oblique fibers spread out fanwise, so that the middle of the longitudinal bundle is covered by a complete, but thin, layer of oblique fibers. The oblique fibers do not pass freely across the intervals, but lie on the inner edge of extremely thin connective-tissue septa which rise from the outer side of the interval (fig. 4) which, as Spengel says, are like dams across the interval, separating it into a great number of small 4-sided compartments opening into the cœlom between the oblique bundles. These "septal bands" are, as Spengel says, composed of the cell-poor connective tissue of the muscle layer, but in my specimens the septal bands have been found to contain a few isolated muscle fibers.

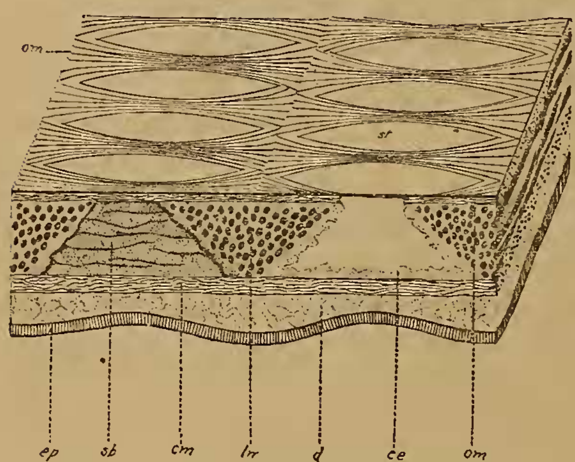

FIG. 2. Diagram of the body wall of *Thalassema griffini* sp. nov. *ep*, epidermis; *d*, dermis; *cm*, circular muscle; *lm*, longitudinal muscle in transverse section; *om*, oblique muscle; *sb*, septal band; *ce*, cœlomic epithelium; *st*, stomata in cœlomic surface.

The entire inner surface, including the intervals, the oblique muscles, and the bands, is covered by an endothelium composed of small, rounded, irregular cells. From this description it will be readily seen (1) that the body wall is divided into 18 longitudinal intermuscular spaces; that is, "intervals," by the 18 longitudinal bundles; and (2) that these intervals are again divided transversely into rows of narrow compartments, "stomata," by the septal bands and oblique bundles. As each one of these "stomata" is connected with the cœlom, they are, of course, filled with the cœlomic fluid, and as Spengel points out the contraction of the muscles would account for the small square "Buckeln der Haut" which are so characteristic of the living animal.

As to the function of these stomata, when we consider that they are covered only by the corium and a very thin layer of circular muscle, it seems very reasonable to assume that they are more or less closely associated with the respiration of the animal.

The importance of the dermal muscle layer, as a means of classification, will be discussed later.

THE ALIMENTARY CANAL

The alimentary canal is about four times as long as the body. For the first fourth, its course is definite, but the remainder seems to vary a little in different individuals. As in most worms the differentiation of the various parts of the canal is so slight that it has been very difficult to assign definite names and functions to them. This form does not seem to agree with any of the published descriptions which are at hand. The part of the canal from the mouth to the beginning of the intestine has been described differently in almost every species. Reitsch calls it simply "intestine buccal;" Spengel divides it into pharynx, œsophagus, and crop; Jameson speaks of the pharynx, œsophagus, gizzard, and crop of *T. neptunii;* Embleton divides this region of *Echiurus unicinctus* into pharynx, crop, and gizzard; and Ikeda describes a pharynx, œsophagus, crop, and midgut in *T. tænoides*. Moreover, this difference is not simply a difference in names but in the structure of the parts themselves. For example, in *Echiurus unicinctus*, the gizzard, which has very thick walls of circular muscle, reduced epithelium, and no glands, corresponds in position to the midgut of *T. tænoides* in which the epithelium is folded and glandular and in which thin layers of both longitudinal and circular muscles are present.

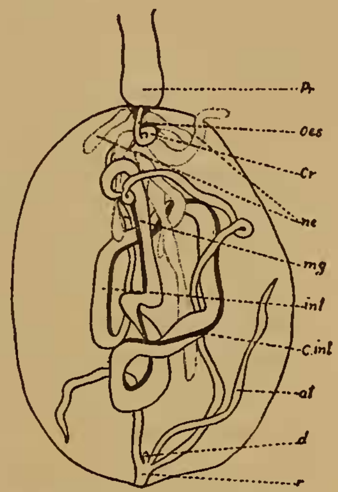

FIG. 3. Diagram of the internal organs of *Thalassema griffini* sp. nov. *pr*, proboscis; *ne*, nephridial sacs; *oes*, œsophagus; *cr*, crop; *mg*, midgut; *int*, intestine; *c. int*, collateral intestine; *r*, rectum; *d*, diverticulum; *at*, anal trees.

In *T. griffini* three distinct regions can be made out in this part of the alimentary canal. These may be called œsophagus, crop, and midgut for want of better terms to describe them. They are followed by the intestine and rectum. The œsophagus is a straight tube about 1 to 2 cm. long and 2 mm. in diameter. The epithelium is ciliated, and is slightly folded. The muscle layer is rather thicker at the anterior end than in any other part, but the difference is not great enough to justify speaking of it as a pharynx. The upper part is held in position by means of a mesentery radiating to the body wall. At the posterior end, the dorsal surface is covered by the "heart," and the two "connecting vessels" pass around it on opposite sides. The crop is about 1 cm. long and from 2 to 3 mm. in diameter. It forms a loop at the end of the œsophagus and turns to the left. It is the thickest part of the canal, the thickness being due, not to muscles, but to the large villus-like folds of the epithelium. The remainder of the canal in front of the intestine is the midgut. It passes posteriorly from the crop almost to the end of the body and forms a U, turning again anteriorly. Here it widens into the intestine. The midgut has a little larger diameter than the crop, but the walls are very thin, and the folds of the epithelium are much reduced. The beginning of the intestine is marked by the opening of the collateral intestine, the siphonal groove not extending beyond it. The intestine can as usual be divided into 2 parts, the first part in this species being much shorter than the second, which begins at the end of the collateral intestine and extends to the rectum. It bears a siphonal groove all the way to the rectum. The first part is the widest region of the alimentary canal, having a diameter of about 4 mm., while the second part is considerably smaller. The walls of both are very thin. The rectum is short, and into it on the left side open the 2 anal trees. A small spherical diverticulum lies between them, and is attached by muscular filaments to the sheath of the nerve cord.

The œsophagus, crop, and intestine are held in place by means of thick muscular filaments attached to their ventral surface. The midgut is not attached to the body wall. A radiating mesentery connects the rectum to the posterior part of the body wall.

Microscopic structure.—The wall of the œsophagus (fig. 6) is composed of three layers—the epithelium, the muscle and connective-tissue layer, and the cœlomic endothelium. The epithelium consists of a layer of very long, slender, ciliated cells with small nuclei at their bases. Lying between the ordinary cells and opening on the surface are a great many long club-shaped gland cells containing a granular material which is more or less vacuolated. The submucous layer consists of a connective tissue in which the muscle fibers are held. It varies in thickness on account of the folding of the epithelium. The connective-tissue cells are small with large nuclei and very long fibrous outgrowths. In the inner part of this layer, muscle fibers of various kinds are regularly scattered, becoming more compactly arranged toward the outer surface. In the upper part of the œsophagus, from which the figure is taken, the muscle is moderately thick, but it gradually becomes thinner and less compact toward the posterior end. The endothelium consists of irregular, rounded cells which are very indefinite and indistinct, and seem to lie in a matrix of some kind. The basement membrane is distinct.

The structure of the crop (fig. 7) differs considerably from that of the œsophagus. The folds of the mucous membrane increase so greatly that the surface seems to be covered with villi. The epithelium is of the pseudo-stratified columnar type, ciliated in the anterior part. The nuclei of the cells present a very peculiar arrangement of the chromatin. In the newly formed cells lying near the base of the epithelial layer, the chromatin is in the form of many small discrete granules which do not appear to be connected by any chromatin network. As the cells approach the surface of the epithelium, the number of these granules decreases. Finally, near the surface the nuclei of some cells are clear and apparently altogether lacking in chromatin. Small droplets of mucin appear in a fairly regular row just below the inner surface of the epithelium. The main part of the villi consists of connective tissue. In the outer part of the submucous layer is a thin layer of circular muscles, and on the outside of this, particularly toward the posterior end, is a thin layer of longitudinal fibers. The endothelium is more regular than that of the œsophagus.

The walls of the midgut are much thinner than those of either the œsophagus or crop. The projections of the mucous membrane are in the form of low, parallel ridges running longitudinally, with a thin layer of epithelium and a very loose connective-tissue layer. Here we have a definite sheet of longitudinal muscle fibers on the inside, but this has a thickness of only 2 or 3 fibers, and outside of it is a thin layer of circular muscles. In both the crop and the midgut the circular muscles are scattered loosely in the connective tissue.

The walls of the first part of the intestine are very thin, but have much the same general structure as the midgut. The submucous layer is very loose, so that in some places there seem to be sinuses. The collateral intestine has thicker walls, but they seem to be of the same general arrangement as the main part of the intestine. The second part of the intestine has the siphonal groove running its entire length to the rectum.

Vascular and nervous systems.—These two systems of organs do not require description as they agree very closely with the ordinary forms.

Reproductive system.—In all the specimens which were dissected, the nephridial sacs were full of spermatozoa or well-developed eggs; also, in the stomata of the body wall numbers of unripe eggs were often encountered, but although sections were studied from almost every part of the body, including the sheath of the nerve cord, the blood vessels, the body walls, and the nephridial sacs, no traces of reproductive tissue of any kind were discovered. Therefore, it seems probable that the formation of ova or spermatozoa must be limited to definite seasons. From the finding of the partially developed eggs in the stomata, it would seem probable that they are developed from the body wall.

A REVISION OF THE GENUS THALASSEMA

Since the publication of Shipley's paper on the revision of the Echiuroidea in 1899, in which there is given a key to the genus *Thalassema* and a brief outline of the characters of the then known species, there has been no attempt to revise the genus as a whole. In the meantime, the number of known species assigned to this genus has increased from 22 to 35. Also, a number of the species mentioned by him have been obtained in new localities, and in some cases important details have been added to the descriptions.

Shipley bases his classification, first, on the condition of the longitudinal muscles of the dermal muscle layer and, secondly, on the number of pairs of nephridia. In 1912, Spengel(43) provisionally divides the group into 3 genera on the basis of the microscopic structure of the dermal muscle layer, without regard to the number or arrangement of the nephridia. The characteristics of these 3 genera have been stated already (page 252). In regard to the first two genera, *Thalassema* and *Listriolobus*, the comparison of the muscle layers of *T. sorbillans* at different stages (page 244) seems to indicate that these two are too closely related to be separated into distinct genera; the condition found in the *Listriolobus* type—a thickening and thinning of the muscular layer—seems to be brought about, from the form in which the muscle is uniform in thickness, by a growth in the regions of the bundles and a consequent pulling apart and thinning of the interbundle region. In fact, in the 4 individuals of *T. sorbillans* which were examined, all the stages from one with a slight thickening but an almost continuous and uniform layer to a differentiation into distinct bundles may be seen. In *T. formosulum* a condition midway between the two extremes seems to exist. In the case of *T. griffini* and of *T. erythrogrammon* of Rüppell, if we study only that part of the dermal muscle layer in which the bundles are seen, it would seem to be entirely different from the other forms (figs. 3 and 4), and only a study of the development of the species would show how this differentiation has occurred. However, a glance at a section of the body wall taken in the anterior terminal region (fig. 5), in which the longitudinal muscle is continuous and uniform in thickness, will cast grave doubts on the essential difference of this characteristic also. From these facts it seems probable that with more material at hand it would be possible to arrange a series showing the gradual differentiation of the muscles from *T. neptunii* at one end to *T. griffini* at the other.

Therefore, it does not seem advisable to take the dermal muscle layer as the essential characteristic for a division of the group. The other character suggested and used by Shipley in his key to the species of *Thalassema;* that is, the number of pairs of nephridia, seems then to be the most important and essential ontogenetic character on which to base the larger divisions of the group, going back as it does in the ontogeny of the group to the disappearance of the segmentation. It seems probable that the most primitive type in the group is that in which 3 or more pairs of nephridia are present; the greater number of pairs, the more primitive the form. Undoubtedly, the simplest forms in that group are those which have a continuous and uniform longitudinal muscle layer. From this type the differentiation of the nephridia occurs in two directions. First, that in which more than 2 nephridia are developed in each segment; as, for example, in *T. elegans* Ikeda. Secondly, that in which the nephridia decrease in number to 2 pairs or 1 pair. As proof of this, a note on the variation of the nephridia in *T. neptunii* by Stewart(44) is of interest. He found, in dissecting some specimens of this species from Plymouth, 1 individual in which a third unpaired nephridium was present, on one side, midway between the first and second pairs. By taking careful measurements on this abnormal individual and a number of other normal specimens, he came to the conclusion that this abnormal nephridium represented a segment, lying between the 2 segments which regularly bear the nephridia, from which in normal individuals the original pair of nephridia has been lost.

From a study of the position of the nephridia of those forms having only 1 pair of nephridia, it seems probable that that pair represents the most anterior pair in those forms with 2 and 3 pairs and that in the differentiation from 3 pairs to 1, first, the middle pair disappears and then the posterior pair. Therefore, in this arrangement of the species of the group, it has been divided; first, according to the number of nephridia and, secondly, according to the arrangement of the muscles and other less essential characters.

In examining the various species of *Thalassema* which have been described, 1 species is found which varies from the *Thalassema* type in such essential characteristics that I propose to make it the type of a new genus, and possibly it ought to be made the type of a new family. This is the species described by Ikeda(20) as *T. tænoides.* Its most striking character is its enormous size, its total length being some 2 meters. On taking its internal structure into account, there are two very deep lying and essential differences from the *Thalassema* type. They are: first, the number and arrangement of the nephridia and, secondly, the position of the longitudinal muscle in the dermal muscle layer. In all other species of *Thalassema* the nephridia are always in pairs or paired groups, the greatest number of pairs recorded being 4, in *T. decameron* Lanchester; and of paired groups, 8, in *T. gogoshimense* Ikeda.

In this form there are an enormous number of nephridia which are not arranged in pairs, but are scattered irregularly on each side of the nerve cord. Ikeda says:

> They were never less than 200 in total number, and in certain individuals I have estimated this to be nearly 400. Moreover, unlike all other known Echiuroids, there is no indication of their segmental arrangement nor of their strictly paired disposition. On the contrary, they occur densely and irregularly crowded together in two longitudinal zones, one on each side of the ventral nerve cord, beginning in front just behind the ventral hooks and extending posteriorly to a length of 10 to 18 cm.

Also, there are no spirally twisted internal openings, but all the nephridia end in a terminal funnel.

In all the *Thalassema* where descriptions of the dermal muscle layer are given, the longitudinal muscle always is found lying between the circular and oblique layers. In this species Ikeda says that the muscle layers are as usual, but his figure of the body wall shows that the thick longitudinal layer lies directly under the corium and to the outside of both the circular and oblique layers.

On account of these characters, I propose to erect the genus *Ikeda* with the following characteristics:

Genus IKEDA novum

Nephridia, indefinite in number, not arranged in pairs, and provided with terminal funnels; longitudinal muscle of the dermal musculature lying on the outside of the circular and oblique layers. This genus at the present time includes only the type species, *Ikeda tænoides* (Ikeda).

On account of the scattered condition of the literature on *Thalassema*, it has seemed advisable to give as nearly as possible a complete bibliography of each species of *Thalassema*, and this has been added at the end of the key to the genera *Thalassema* and *Ikeda* which follows.

Key to the genera Thalassema and Ikeda.

*a*¹. Gephyrea in which the nephridia are arranged in pairs. The longitudinal muscle of the dermal muscle layer lies between the circular and oblique layers. No posterior ring of setæ.. Genus Thalassema Gaertner.
- *b*¹. Forms possessing 1 pair of nephridia.
  - *c*¹. Longitudinal muscles continuous.
    - *d*¹. Nephridia without spirally coiled internal openings.
      - *e*¹. Proboscis about as long as the body and forming a tube just before it joins the body. Anal trees very short and transparent like glass.. T. diaphanes Sluiter.
      - *e*². Proboscis small. Anal trees of moderate size with irregular branches .... T. faex Selenka.
      - *e*³. Proboscis less than half the length of body. Anal trees bear large funnels situated close together on long stalks. T. owstoni Ikeda.
      - *e*⁴. Proboscis about ½ length of body. Anal trees as long as body with few short, ciliated funnels......................... T. fuscum Ikeda.
      - *e*⁵. Proboscis trilobed at tip. Anal trees short and sac-like. T. gigas Max Müller.
      - *e*⁶. Proboscis short. Anal trees short, with funnels on short stalks. Anal trees attached to body by means of muscular filaments. T. arcassonensis Cuenót.
    - *d*². Nephridia with spirally coiled internal openings.
      - *e*¹. Proboscis bilobed. Anal trees branched with funnels at tips of branches .... T. lankesteri Herdman.
  - *c*². Longitudinal muscles forming bundles which may or may not be separated.
    - *d*¹. Nephridia with spirally coiled internal openings.
      - *e*¹. 10–11 muscle bundles. Proboscis about ⅓ the length of body. T. hupferi Fischer.
- *b*². Forms possessing 2 pairs of nephridia.
  - *c*¹. Longitudinal muscle continuous.
    - *d*¹. Length of proboscis 3 to 4 times the length of body when expanded. T. neptunii Gaertner.

d^{2}. Proboscis $\frac{3}{4}$ as long as body. Anal trees thin and brown and over half as long as body.. **T. semoni Fischer.**

d^{3}. Proboscis short. Anal trees short............ **T. sabinum Lanchester.**

c^{2}. Longitudinal muscles forming bundles which may or may not be separated by "intervals."

d^{1}. 7–8 muscle bundles. Proboscis $\frac{1}{3}$ as long as body. Anal trees broad and sac-like.................................. **T. formosulum Lampert.**

d^{2}. 8 muscle bundles. Proboscis several times as long as the body. **T. mellita Conn.**

d^{3}. 8–10 muscle bundles. Anal trees small............ **T. exilii Fr. Müller.**

d^{4}. 13 muscle bundles. Proboscis longer than body. Anal trees short with simple diverticula, each ending in a funnel. **T. pellucidum Fischer.**

d^{5}. 14 muscle bundles. Anal trees longer than half the body. Rectal diverticulum present.................................. **T. manjuyodense Ikeda.**

d^{6}. 17–19 muscle bundles. Proboscis shorter than body. Anal trees long with short branching outgrowths............ **T. baronii Greef.**

b^{3}. Forms possessing 3 pairs of nephridia. Always with spirally coiled internal openings.

c^{1}. Anterior pair of nephridia opening in front of ventral setæ.

d^{1}. Longitudinal muscles continuous.

e^{1}. Proboscis one-half as long as body. Anal trees long and brown with few small funnels................................ **T. inanense Ikeda.**

e^{2}. Proboscis as long as body. Anal trees long and brown with microscopic funnels.. **T. moebii Greef.**

d^{2}. Longitudinal muscles forming bundles which may or may not be separated by "intervals." No interbasal muscle. Funnels of anal trees always sessile.

e^{1}. 13 muscle bundles. Proboscis over $\frac{1}{2}$ as long as body. Anal trees long with microscopic funnels. Rectal diverticulum. **T. sorbillans Lampert.**

e^{2}. 14 muscle bundles. Proboscis shorter than body. Anal trees thin and brown. Rectal diverticulum. **T. erythrogrammon Max Müller.**

e^{3}. 15–16 muscle bundles. Anal trees $\frac{1}{2}$ as long as body with prominent funnels.................................. **T. stuhlmanii Fischer.**

e^{4}. 15–17 muscle bundles. Anal trees with numerous funnels. Rectal diverticulum.. **T. leptodermon Fischer.**

e^{6}. 16–18 muscle bundles. Proboscis $\frac{1}{3}$ as long as body. Anal trees with long brown tubes................................ **T. caudex Lampert.**

e^{6}. 17–18 muscle bundles. Proboscis short. Anal trees with well-marked funnels...................................... **T. kokotoniense Fischer.**

e^{7}. 17–18 muscle bundles. Proboscis $\frac{3}{5}$ as long as body. Anal trees $\frac{3}{4}$ length of body with small funnels. Rectal diverticulum. **T. griffini sp. nov.**

c^{2}. All three pairs of nephridia open behind the ventral hooks. Longitudinal muscle continuous.

d^{1}. Proboscis absent (?). Anal trees thin, long, and brown. **T. vegrande Lampert.**

d^{2}. Proboscis short. Anal trees $\frac{1}{2}$ the length of body with small funnels .... **T. mucosum Ikeda.**

b^4. Forms possessing more than 3 pairs of nephridia.

c^1. 4 pairs of nephridia. Longitudinal muscle divided into 10 bundles. T. decameron Lanchester.

c^2. Nephridia arranged in paired groups, each group containing a varying number of nephridia. Longitudinal muscle continuous.

d^1. 7 paired groups with 1–3 nephridia in each group..........T. elegans Ikeda.

d^2. Nephridia in female in 3 pairs. In male in 3 to 8 paired groups with 1–4 nephridia in each group............ T. gogoshimense Ikeda.

a^2. Gephyrea of unusually large size in which the nephridia are indefinite in number, not arranged in pairs, and are provided with terminal funnels. The longitudinal muscle of the dermal muscle layer lies on the outside of the circular layer............ Genus Ikeda Wharton nov.

b^1. Body length 40 cm. Proboscis length 150 cm., nephridia 200–400 in number. Anal trees 6–7 cm. in length, fixed at the tip by a muscle, and covered with tubules bearing funnels.... Ikeda tænoides (Ikeda).

NOTE. *T. viridis* Verrill, *T. verrucosa* Studer, and *T. papillosum* (Delle Chiaje) have not been included in the key. The first two because of the indefiniteness of their descriptions, and the last because I have not seen the description.

BIBLIOGRAPHY AND GEOGRAPHICAL DISTRIBUTION OF THE SPECIES OF THALASSEMA GAERTNER AND IKEDA WHARTON

THALASSEMA Gaertner

1. Thalassema arcassonensis Cuenót.
   CUENÓT, Procès-verb. Soc. Bordeaux (1902), 6, 1–28. Locality: Archachon.

2. Thalassema baronii Greef.
   GREEF, Nova Acta Acad. German. (1879), 41, pt. 2, 151; SELENKA, Challenger Results (1885), 13, pt. 36, 8; SHIPLEY, Proc. Zool. Soc. London (1899), 55; Willey's Zool. Results (1899), pt. 3, 345; LANCHESTER, Proc. Zool. Soc. London (1905), 34. Localities: Lazarote, Canary Is. Bahia 7–20 fath., Christmas Is. Lifu, Loyalty Is., Zanzibar.

3. Thalassema caudex Lampert.
   LAMPERT, Zeitschr. f. wiss. Zool. (1883), 39, 340; SHIPLEY, Proc. Zool. Soc. London (1894), 472; Willey's Zool. Results (1899), pt. 3, 346; SPENGEL, Verhandl. d. deutsch. zool. Ges. a. d. 120. Jahresvereins zu Halle (1912). Localities: Red Sea, Indian Ocean, Rotuma.

4. Thalassema decameron Lanchester.
   LANCHESTER, Proc. Zool. Soc. London (1905), 35. Localities: Chewaka, Zanzibar.

5. Thalassema diaphanes Sluiter.
   SLUITER, Natuurk. Tijdschr. v. Nederl. Ind. (1888), 48, 244; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 366 and 346; Fauna, etc., Maldive & Laccadive Arch. (1902) 1, pt. 2, 128. Localities: Bay of Batavia 110–12 fath., Pigion Island, New Britain, Hulule, Maldive Is., Minikoi, Laccadive Is.

6. Thalassema elegans Ikeda.
IKEDA, Journ. Col. Sci., Imp. Univ. Tokyo (1905), 20, 65; Journ. Col. Sci. Imp. Univ. Tokyo (1907), 21, 47–55. Locality: Japan.

7. Thalassema erythrogrammon Max Müller.
GREEF, Nova Acta Acad. German. (1879), 41, pt. 2, 147; VON DRASCHE, Verh. Ges. Wien. (1881), 30, 624; SLUITER, Natuurk. Tijdschr. v. Nederl. Ind. (1884), 43, 58; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 347; WILSON, Biol. Bull. Woods Hole (1900), 1, 174; SHIPLEY, Fauna, etc., Maldive & Laccadive Arch. (1902), 1, pt. 2, 128; SPENGEL, Verhandl. d. deutsch. zool. Ges. a. d. 120. Jahresvereins zu Halle (1912). Localities: Red Sea, Isle de Bourbon, Billiton, Malay Penin., China Strait, New Guinea, Hulule, Maldive Islands, Bahamas, Florida.

8. Thalassema exilii Fr. Müller.
LAMPERT, Zeitschr. f. wiss. Zool. (1883), 39, 341; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 347. Locality: Destino, in Brazil.

9. Thalassema faex Selenka.
SELENKA, Challenger Reports (1885), 13, 7; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 347. Locality: Off the coast of Norway.

10. Thalassema formosulum Lampert.
LAMPERT, Zeitschr. f. wiss. Zool. (1883), 39, 339; SHIPLEY, Willey's Zool. Results (1889), pt. 3, 348. Localities: Cavite and Samar, Philippines; Shanghai.

11. Thalassema fuscum Ikeda.
IKEDA, Journ. Col. Sci., Imp. Univ. Tokyo (1905), 20, Act. 4, 69. Locality: Japan.

12. Thalassema gigas Max Müller.
GREEF, Nova Acta Acad. German. (1879), 41, pt. 2, 149; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 348. Locality: Trieste.

13. Thalassema gogoshimense Ikeda.
IKEDA, Journ. Col. Sci., Imp. Univ. Tokyo (1905), 20, Act 4, 66. Locality: Gogoshimense and Morioso, Japan.

14. Thalassema griffini Wharton, sp. nov.
Locality: Mindoro, Philippines.

15. Thalassema hupferi Fischer.
FISCHER, Abh. Ver. Hamburg (1895), 13, 20; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 348. Locality: Nyango, W. Africa.

16. Thalassema inanense Ikeda.
IKEDA, Journ. Col. Sci., Imp. Univ. Tokyo (1905), 20, Art. 4, 71. Locality: Inanense, Japan.

17. Thalassema kokotoniense Fischer.
FISCHER, Jahrb. Hamburg. Wissensch. Anstalt (1891), 9, pt. 2, 82; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 349; IKEDA, Journ. Col. Sci., Imp. Univ. Tokyo (1905), 20, pt. 4, 60. Localities: Kokotani, E. Africa; Blanche Bay, New Britain; Japan.

18. Thalassema lankesteri Herdman.
HERDYAN, Quart. Journ. Micros. Sci. (1898), n. s. 40, 381; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 349. Locality: Off the Isle of Man; 50 fath.

19. Thalassema leptodermon Fischer.
FISCHER, Jahrb. Hamburg. Wissensch. Anstalt (1891), 9, pt. 2, 84, 1 pl.; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 349. Locality: Zanzibar, Bueni Riff.

20. Thalassema manjuyodense Ikeda.
IKEDA, Ann. Zool. Japan (1903–06), 5, 172. Locality: Negros, Philippines.

21. Thalassema mellita Conn.
CONN, Stud. Johns Hopkins Univ. (1884–87), 3, 351; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 350; TORREY, Ann. N. Y. Acad. Sci. (1903), 14, 165. Locality: Beaufort, North Carolina, U. S. A.

22. Thalassema moebii Greef.
GREEF, Nova Acta Acad. German. (1879), 40, pt. 2, 152; VON DRASCHE, Verh. Ges. Wien (1881), 30, 621; FISCHER, Zool. Forschungsr. in Australien, etc., Semon (1896), 5, pt. 3, 338; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 350; Fauna, etc., Maldive & Laccadive Arch. (1902), 30, pt. 2, 129; LANCHESTER, Proc. Zool. Soc. London (1905), 34. Localities: Mauritius, Amboina, Upolu, Hulule, Minikoi, Zanzibar.

23. Thalassema mucosum Ikeda.
IKEDA, Journ. Col. Sci., Imp. Univ. Tokyo (1905) 20, Art. 4, 68. Locality: Moroiso, Japan.

24. Thalassema neptunii Gaertner.
GREEF, Nova Acta Acad. German. (1879), 41, pt. 2, 145; LANKESTER, Zool. Anzeiger (1881), 350; CAMUS, Bull. Soc. Sci. Nat. Ouest France II (1892); SHIPLEY, Willey's Zool. Results (1899), pt. 3, 331; JAMESON, Zool. Jahrb., Abt. Anat. (1899), 12. Localities: English Channel, South Irish Coast, Bay of Biscay.

25. Thalassema owstoni Ikeda.
IKEDA, Journ. Col. Sci., Imp. Univ. Tokyo (1905), 20, Art. 4, 62. Locality: Uraga Channel, Japan.

26. Thalassema papillosum (Delle Chiaje).
JAMESON, Mitth. a. d. zool. Stat. Neapel (1819), 13, 1899.

27. Thalassema pellucidum Fischer.
FISCHER, Abh. Ver. Hamburg (1895), 13, 19; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 351. Locality: Whydah, W. Africa.

28. Thalassema sabinum Lanchester.
LANCHESTER, Proc. Zool. Soc. London (1905), 40. Locality: Tale Sab, Singora.

29. Thalassema semoni Fischer.
FISCHER, Zool. Forschungsr. in Australien, etc., Semon (1896), 5, pt. 3, 338; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 351; Fauna, etc., Maldive & Laccadive Arch. (1902), 1, pt. 2, 129. Locality: Amboina, Hulule, Maldive Is.

30. Thalassema sorbillans Lampert.
LAMPERT, Zeitschr. f. wiss. Zool. (1883), 39, 340; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 352. Locality: Philippines.

31. Thalassema stuhlmanii Fischer.
FISCHER, Jahrb. Hamburg. wissensch. Anstalt (1891), 9, pt. 2, 82; Abh. Ver. Hamburg (1895), 13, 20; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 352. Localities: Zanzibar, Bueni Riff; Pangani, Ras. Muhasa.

32. Thalassema vegrande Lampert.
LAMPERT, Zeitschr. f. wiss. Zool. (1883), 39, 341; SHIPLEY, Proc. Zool. Soc. London (1848), 472; Willey's Zool. Results (1899), pt. 3, 352; Fauna, etc., Maldive & Laccadive Arch. (1902), 1, pt. 2, 130. Locality: Philippines, Rotuma, Hulule.

33. Thalassema verrucosa Studer.
STUDER, Arch. f. Naturg. (1879) 45, 124. Locality: Betsy Cove, Kerguelen.

34. Thalassema viridis Verrill.
VERRILL, Proc. U. S. Nat. Mus. (1879), 2, 183; SHIPLEY, Willey's Zool. Results (1899), pt. 3, 353. Locality: Off Head Harbor, Campo Billo Is., U. S. A.

IKEDA Wharton, genus novum

35. Ikeda tænoides (Ikeda).
Thalassema tænoides IKEDA, Journ. Col. Sci., Imp. Univ. Tokyo (1905), 20, Art. 4, 63; Journ. Col. Sci., Imp. Univ. Tokyo (1907), 21, Art. 4, 16–47. Locality: Misiki Marine Laboratory, Corcan Strait, Gulf of Tokyo, Japan.

LITERATURE ON THALASSEMA

(1) AUGENER, H. Beiträge zur Kenntnis der Gephyreen nach Untersuchung der im Göttinger zoologischen Museum befindlichen Sipunculiden und Echiuriden. *Arch. f. Naturg.* (1903), 69, 297–371.

(2) AUSTRALIAN MUSEUM, SYDNEY. List of the Gephyrean worms of Furafuti (1899), Memoir 3.

(3) BAND, W. Monograph of the species of worms belonging to the subclass Gephyrea. *Proc. Zool. Soc. London* (1868), 77–114.

(4) COLLIN, A. Gephyreen gesammelt von Herrn Oberstabsarzt Dr. Sander anf der Reise S. M. S. Prinz Adalbert. *Arch. f. Naturg.* (1892), 58, 177–182, Pl. xi.

(5) CONN, H. W. Life history of *Thalassema mellita. Stud. from the Biol. Lab. Johns Hopkins Univ.* (1884–1887), 3.

(6) CUENÓT, L. Contributions à la fauna du bassin d'archachon (Echiuriens et Sipunculiens). *Procès-verb. Soc. Bordeaux* (1902), 6, 1–28, 1 pl.

(7) EMBLETON, ALICE L. On the structure and affinities of *Echiurus uniunctus. Trans. Linn. Soc.-Zool. London* (1900), II, 8, 77–97, 4 pls.

(8) FISCHER, W. Übersicht der von Herrn Dr. Fr. Stuhlmann auf Sansibar und ander gegenüberliegenden Festlandküste gesammelte Gephyreen. Jahrb. d. Hamburg. wissensch. Anstalt (1892), 9, 79–89.

(9) IDEM. Die Gephyreen des naturhistorischen Museums zu Hamburg. *Abh. a. d. Gebiete d. Naturwiss.* (1895), 13.

(10) IDEM. Gephyreen. Hamburg. Magalhaensische Sammelreise. Hamburg (1896).

(11) IDEM. Gephyreen. Zool. Forschungsreisen in Australien und dem Malayischen Archipel. *Denkschriften d. med.-naturwis. Ges. Jena* (1896), 8, pt. 3, 337–39.

(12) FORBES and GOODSIR. Natural history of Thalassema and Echiurus. Edinburgh. *New Phil. Journ.* (1841), 30.

(13) GREEF. R. Die Echiurien (Gephyrea armata). *Nova Acta Acad. German.* (1879), 40, pt. 2, 152.

(14) IDEM. Über den Bau der Echiurien. *Sitzungsber. d. Ges. z. Beförd. d. gesamm. Naturw. z. Marburg.* (1879).

(15) IDEM. Über die Organisation der Echiuriden. *Sitzungsber. d. Ges. z. Beförd. d. gesamm. Naturw. z. Marburg* (1874).

(16) HATSCHEK, B. Über Entwicklungsgeschichte von Echiurus und die systematische Stellung der Echiuridae. *Arb. a. d. zool. Station Triste* (1880), 3, 45–79, Pl. 4–6.

(17) HERDMANN, W. Note on a new British Echiuroid Gephyrean with a remark on the genera Thalassema and Hamingia. *Quart. Journ. Micros Sci.* (1897), 40, 367.

(18) IKEDA, IWAJI. Gephyreans collected by Prof. Dean at Marignyodi, Southern Negros, P. I. *Annot. Zool. Jap. Tokyo* (1905), 5, 169–174.

(19) IDEM. The Gephyrea of Japan. *Journ. Col. Sci., Imp. Univ. Tokyo* (1905), 20, Art. 4.

(20) IDEM. On three new and remarkable species of Echiuroids, *Bonella aiyajamai, Thalassema tænoides,* and *Thalassema elegans. Journ. Col. Sci., Imp. Univ. Tokyo* (1907), 21, Art. 8.

(21) JAMESON, L. H. Contributions to the anatomy and histology of *Thalassema neptunii* Gaertner. *Zool. Jahrb. Jena, Abt. Anat.* (1899), 12, 535–556, pl. 28–30.

(22) IDEM. *Thalassema papillosum* (Delle Chiaje). A forgotten Echiuroid Gephyrean. *Mitth. a. d. zool. Stat. Neapel* (1899), 13.

(23) LAMPERT, K. Über einige neue Thalassema. *Zeitschr. f. wiss. Zool.* (1883), 39, 334.

(24) LANCHESTER, W. F. I. Marine fauna of Zanzibar. Gephyrea. II. Sipunculids and Echiuroids from the Skect expedition to the Malay Peninsula. *Proc. Zool. Soc. London* (1905), 28–41.

(25) LANKESTER, R. On *Thalassema neptunii* G. *Zool. Anz. Leipzig* (1881), 87, 350–356.

(26) POURTALES, L. Gephyreans of the Atlantic Coast of North America. *Am. Assoc. Adv. Sci. for 1851* (1852), 5, 39–42.

(27) QUATREFAGES. Historie des Anneles (1865), 2.

(28) REITSCH, M. Études sur les Gephyris armes ou Echiuriens. Thèse de doctorat, Paris (1886), and Recuil Zoologique Suisse (1886), 3.

(29) RÜPPELL et LEUCKART. Atlas zu der Reise im Nördlichen Afrika. Zoologie (1828), Pl. 2.

(30) SELENKA, EMIL. Challenger Report on Gephyrea (1885), 13, pt. 2, 1–25, 4 pls.

(31) SHIPLEY, A. E. Gephyrea. The Cambridge Natural History (1896), 2, 411–449, 25 figs.

(32) IDEM. A report on the Gephyrea collected by Mr. J. Stanley Gardiner at Rotuma and Funafuti. *Proc. Zool. Soc. London* (1898), 468.

(33) IDEM. Notes on a collection of Gephyrean worms found at Christmas Island by Mr. C. W. Andrews. *Proc. Zool. Soc. London* (1899), 35–41.

(34) IDEM. On a collection of Echiuroids from the Loyalty Islands, etc. Willey's Zool. Results (1899), pt. 3, 335–355, 2 pl.

(35) IDEM. Fauna and geography of the Maldive and Laccadive Archipelagoes. Echiuroidea (1902), **1**, pt. 2, 127–130, 1 pl.

(36) SKORIKOV, A. Gephyrea aus der zoologischen Ausbeute des Eisbrechers "Ermak" im Sommer 1901. *Annuaire Mus. St. Petersb.* (1903), **8**, 274.

(37) SLUITER, C. Beiträge z. Kenntnis der Gephyreen aus dem Malayischen Archipel. *Natuurk. Tijdschr. v. Nederl. Ind.* (1881), **41**, 495.

(38) IDEM. Die Evetebraten aus der Sammlung des königlichen naturwissenschaftlichen Vereins in Niederländisch Indien in Batavia. *Natuurk. Tijdschr. v. Nederl. Ind.* (1890), **50**, 102–125, 2 pls.

(39) IDEM. Gephyreens provenant des campagnes de l'Hirondelle et de la Princesse Alice 1886–97. Resultats des campagnes scientifiques accomplies sur son yacht pu Albert I. Prince de Monaco (1900), **15**, 30.

(40) IDEM. Gephyriens provenant des campagnes de la Princesse Alice, 1898–1910. *Ibid.* (1912), **36**.

(41) IDEM. Die Sipuneuloiden und Echiuroiden der Siboga Expedition, nebst Zusammenstellung der überdies aus dem Indischen Archipel bekannten Arten. Siboga Expedition, Monographie (1902), **25**, 1–53.

(42) SPENGEL, J. W. Beiträge zur Kenntnis der Gephyrea. III. Zum Bau des Kopflappens der armaten Gephyreen. *Zeitschr. f. wiss. Zool.* (1912), **101**, 342–384.

(43) IDEM. Über den Hautmuskelschlauch gewisser Thalassema-Arten und seine Bedeutung für die Systematik dieser Tiere. Verhandl. d. deutsch. Zool. Ges. a. d. 120. Jahresvereins zu Halle (1912), 309–17.

(44) STEWART, F. W. Note on the variation of the number of genital pouches in *Thalassema neptunii. Ann. Nat. Hist.* (1900), **5**, 218–219.

(45) STUDER. *Arch. f. Naturg.* (1879), **45**, 124.

(46) TORREY, J. C. The cell lineage of the mesoblast bands and mesenchyme in Thalassema. *Science* (1902), **15**, 576.

(47) IDEM. Early development of the mesoblast in Thalassema. *Anat. Anzeig.* (1902), **21**, 247–256.

(48) IDEM. Eggs of Thalassema from Beaufort, N. C. *Annals N. Y. Acad.* (1902), **14**, 137.

(49) VON DRASCHE. Über eine neue Echiurus-Art aus Japan, etc. *Verhandl. d. k. k. zool. bot. Ges. Wien* (1881), **30**, 621–628, Pl. 30.

(50) WILSON, E. B. Our North American Echiuroids. A contribution to the habits and geographical range of the group. *Biol. Bull. Woods Hole* (1900), **1**, 163–178.

ILLUSTRATIONS

Plate I

Fig. 1. Abnormal crop of *Thalassema sorbillans* Lampert. × 10. (Drawn by Santos.)

2. *Thalassema griffini* sp. nov. Natural size. (Drawn by Espinosa.)
3. Transverse section of the body wall of *Thalassema griffini* sp. nov. from the middle region. (Zeiss ocular 1, objective D, camera lucida outline, reduced ½.)

   ep, epidermis.
   ep. gl, epidermal glands.
   d, dermis.
   cm, circular muscle.
   lmb, longitudinal muscle bundle.
   lmf, interbundle longitudinal muscle fibers.
   cm, oblique muscle.
   st, stomata.
   ce, cœlomic epithelium.
4. Longitudinal section of the body wall of *Thalassema griffini* sp. nov. through an interval in the middle region. (Zeiss ocular 1, objective D, camera lucida outline, reduced ½.)

   ep, epidermis.
   ep. gl, epidermal glands.
   d, dermis.
   dgl, dermal gland.
   lmf, longitudinal muscle fibers.
   cm, circular muscle.
   omb, oblique muscle bundles.
   sb, septal bands.
   ce, cœlomic epithelium.
   st, stomata.

Plate II

Fig. 5. Transverse section of the body wall of *Thalassema griffini* sp. nov. through the anterior terminal region. (Zeiss ocular 1, objective D, camera lucida outline, reduced ½.)

   ep, epidermis.
   ep. gl, epidermal glands.
   d, dermis.
   dgl, dermal glands.
   cm, circular muscle.
   lm, longitudinal muscle.
   om, oblique muscle.
   ce, cœlomic epithelium.

6. Transverse section through the anterior part of the œsophagus of *Thalassema griffini* sp. nov. (Zeiss ocular 3, objective $\frac{1}{12}$, camera lucida outline, reduced ½.)

   epth, epithelium.
   gl, glands.
   ml, muscle layer.
   end, endothelium.
7. Transverse section through the crop of *Thalassema griffini* sp. nov. (Zeiss ocular 3, objective $\frac{1}{12}$, camera lucida outline, reduced ½.)

   epth, epithelium.
   ml, muscle layer.
   md, mucous droplets.
   end, endothelium.
   ct, connective tissue with sinuses.

TEXT FIGURES

FIG. 1. Diagram of the internal organs of *Thalassema sorbillans* Lampert. *pr*, proboscis; *ne*, nephridial sacs; *oes*, œsophagus; *cr*, crop; *giz*, gizzard; *int*, intestine; *c. int*, collateral intestine; *r*, rectum; *d*, diverticulum; *at*, anal trees; *n*, nerve.

2. Diagram of the body wall of *Thalassema griffini* sp. nov. *ep*, epidermis; *d*, dermis; *cm*, circular muscle; *lm*, longitudinal muscle in transverse section; *om*, oblique muscle; *sb*, septal band; *ce*, cœlomic epithelium; *st*, stomata in cœlomic surface.

3. Diagram of the internal organs of *Thalassema griffini* sp. nov. *pr*, proboscis; *ne*, nephridial sacs; *œs*, œsophagus; *cr*, crop; *mg*, midgut; *int*, intestine; *c. int*, collateral intestine; *r*, rectum; *d*, diverticulum; *at*, anal trees.